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Successful Kidney and Lung Transplantation From a Deceased Donor With Blunt Abdominal Trauma and Intestinal Perforation

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The number of organ donors is limited by many contraindications for donation and poor quality of potential organ donors. Abdominal infection is a generally accepted contraindication for donation of abdominal organs. We present a 43-year-old man with lethal brain injury, blunt abdominal trauma, and intestinal perforation. After withdrawal of life-sustaining treatment and circulatory arrest, a minilaparotomy confirmed abdominal contamination with intestinal content. After closure of the abdomen, organs were preserved with in situ preservation with an aortic cannula inserted via the femoral artery. Thereafter, the kidneys were procured via bilateral lumbotomy to reduce the risk of direct bacterial contamination; lungs were retrieved following a standard practice. There was no bacterial or fungal growth in the machine preservation fluid of both kidneys. All organs were successfully transplanted, without postoperative infection, and functioned well after 6 months. We hereby show that direct contamination of organs can be avoided with the use of in situ preservation and retroperitoneal procurement. Intestinal perforation is not an absolute contraindication for donation, although the risk of bacterial or fungal transmission has to be evaluated per case.

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With a continuing shortage of organs for transplantation, loss of donor organs is unfortunate.[1,2] To increase the number of donors, patients of older age with increased morbidity are accepted as donors.[2] This, however, comes with an increased risk of donor-to-recipient disease transmission, a rare, but possibly lethal complication.[3] Therefore, all potential organ donors are screened for contraindications for donation, for example, malignancy or infection and often rejected if found positive. Which donors are safe to use and should not be rejected is a difficult but important question to answer in times of organ shortage.

We report a successful kidney and lung transplantation of a deceased donor with intestinal perforation and massive abdominal contamination with bowel contents by using an alternative procurement approach. Kidneys were cooled and flushed with in situ preservation (ISP) and removed via bilateral lumbotomy. Lungs were retrieved following a standard practice.

Case Description

A 43-year-old man (Table 1) was admitted to the emergency department after a high-speed car accident. At initial assessment, there was severe head and abdominal trauma, with free intraperitoneal air on the abdominal computed tomography (CT) scan, but no evidence of traumatic damage to liver, spleen, pancreas, and kidneys (Figure 1). The patient was transported to the intensive care unit (ICU), without a need for inotropic treatment.

Careful assessment of the cerebral CT scan showed severe contusion and bleeding of the brain with a midline shift and brainstem compression. It was agreed that further treatment would be futile and life-supporting treatment should be discontinued.

Brain death was not expected, and the risk of sepsis after possible intestinal spillage was considerable. Therefore, after the relatives' consent, a donation after circulatory death

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TABLE 1.

Donor information and evaluation

Donor characteristics	
Age	43 y
Sex	Male
Body mass index	25 kg/m^2
Medical history	None
Medication use	None
Cause of death	Trauma
Cardiac arrest	No
Hypotensive periods	1 (30 min)
Situation at time of ventilator switch off	
Systolic blood pressure	125 mm Hg
Diastolic blood pressure	70 mm Hg
Heart frequency	94 beats/min
Oxygen saturation	100%

procedure was initiated. Standard screening of the donor was performed, using medical and social history, physical assessment, blood and urine tests, chest X-ray, bronchoscopy, and abdominal ultrasound. Afterward, the lungs, liver, pancreas, and both the kidneys were accepted for organ donation.

During ICU admission, the donor showed no clinical signs of systemic infection nor did blood tests show substantial increase of infection parameters (ie, white cell count or c-reactive protein). Therefore, with a concomitant low suspicion of intestinal perforation, blood cultures were not collected, and antibiotic treatment was not started.

Ventilator switch off was performed in the ICU, 16 hours and 6 minutes after hospital admission, with circulatory arrest after 10 minutes. Thereafter, the patient's death was declared. The patient was transported to the operating room. A limited lower midline laparotomy and a median sternotomy were simultaneously performed. There was bowel content in the abdominal cavity, and the abdomen was immediately closed. It was decided not to procure the liver and pancreas for transplantation. The abdominal retrieval team changed gloves and surgical equipment and proceeded with ISP, as previously described.[4] Cold perfusion of the abdominal organs, using 13 L of histidine-tryptophan-ketoglutarate solution (Custodiol, Dr. Franz Köhler Chemie, Alsbach, Germany) and 50.000 IE of heparin, started after 24 minutes of warm ischemia. One minute later, perfusion of the lungs was started. After removal of the heart, both lungs were retrieved. Thereafter, the donor was repositioned twice: through a left lumbotomy, the left kidney was retrieved, 35 minutes after the start of abdominal perfusion; and through a right lumbotomy, the right kidney was retrieved 28 minutes later (Table 2).

Both kidneys were preserved with machine perfusion using the Lifeport kidney transporter (Organ Recovery Systems, Des Plaines, IL) and transported to 2 different transplant centers. Macroscopically, they were well perfused, showed no signs of atherosclerosis, and were of good quality. There was no growth of bacteria or fungi in the culture of the machine preservation fluid of both kidneys.

The left kidney was transplanted in a 62-year-old woman with diabetes after 12 hours and 12 minutes of cold ischemia time (Table 3). Postoperatively, there were no complications; dialysis was needed in the first week. Antibiotic or antifungal prophylaxis was not initiated. The recipient did not show any clinical signs of infection and was discharged after 19 days with an acceptable kidney function (estimated glomerular filtration rate [eGFR] of 32 mL/min [MDRD]). After 6 months of follow-up, the recipient had an excellent kidney function (eGFR > 60 mL/min [MDRD]).

The right kidney was transplanted in a 52-year-old man, with a history of hypertension-induced nephrosclerosis. The cold ischemia time was 15 hours and 35 minutes (Table 3). There were no postoperative complications and immediate graft function without the need for postoperative dialysis. Cotrimoxazole 480 mg/d and valganciclovir 450 mg twice per week were given due to extensive use of immunosuppressants (second transplant). Six months of follow-up showed no abnormalities. The kidney function was excellent with an eGFR greater than 60 mL/min (MDRD).

The 37-year-old male recipient of the lungs was given ceftriaxon because of exceptional bacterial lung flora and positive donor sputum cultures on *Staphylococcus aureus* and *Haemophilus parainfluenzae*. He recovered rapidly after transplantation, without signs of infection and with good pulmonary function at discharge and after 6 months.

DISCUSSION

The incidence of intestinal perforation is approximately 0.23% in all trauma patients and up to 5% in patients suffering from severe blunt abdominal trauma.[5,6] In 2014, 18.9% of all donors (385 of 2041 donors) died after a traumatic accident within the Eurotransplant region.[7] It is unknown how many potential donors after trauma are rejected because of intestinal perforation, but this group of patients could provide additional donor organs.

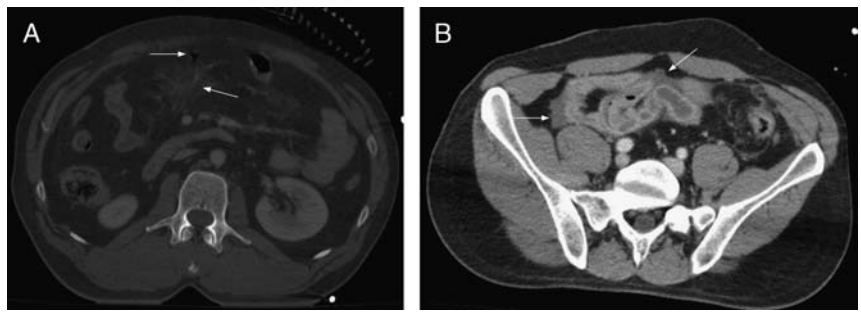

FIGURE 1. A, Abdominal CT scan showing free air and increased infiltration of the mesenteric fat tissue due to mesenteric contusion or hemorrhage. B, Abdominal CT scan showing free fluid in the abdominal cavity.

TABLE 2.

Case description over time

Time	Event
0:00	Car accident
1:30	Admission to hospital
17:36	Ventilator switch off in the ICU
17:46	Time of death
17:51	Incision at OR
18:10	Perfusion of the abdomen (DBTL)
18:11	Perfusion of the thorax
18:45	Left nephrectomy
19:13	Right nephrectomy

DBTL, double balloon triple lumen.

The CT scan is the primary imaging modality to diagnose intestinal perforation.[8,9] Both conventional CT scan (sensitivity, 65%; specificity, 97%) and multidetector CT (sensitivity, 87-95%; specificity, 48-84%) are useful to diagnose surgically important bowel injury.[9,10] The presence of free fluid, free air, and patterns of mesenteric fat stranding were, in retrospect, highly indicative for intestinal perforation in our patient. To reduce warm ischemia time and reduce the risk of further contamination, laparotomy could be omitted in similar cases.

Donor-derived infections are rare but are associated with high morbidity and mortality rates.[3,11-15] In Europe and in the United States, risk stratification by donor screening is performed to evaluate the risk/benefit-ratio for an organ recipient. This includes taking medical and social history, screening for active or latent infections (viral and bacterial) and physical assessment.[3,16,17] An unacceptable risk leads to disqualification of a donor and loss of donor organs.[16,18] Sepsis, bacteremia, and organs with active bacterial infections limited to the organ, unless adequately treated with 24 to 48 hours of antibiotics, are absolute contraindications for organ donation.[19] Fungal infections may lead to life-threatening complications in the recipient. Their source is usually unknown, but it is most likely attributed to exogenous contamination during organ procurement or rupture of an abdominal viscus in the donor.[12,13,15,20-22] Intestinal perforation with intraperitoneal air and free fluid is used as contraindication for organ donation because of the risk of transmitting serious infection to a recipient who inevitably uses immunosuppressants. Our donor did not show signs of sepsis, and adequate exclusion of bacteremia or fungemia was not possible within the short period. Although the lack of a complete diagnostic work-up makes risk stratification challenging, it does not make it a contraindication for donation.[14]

Next to risk stratification, risk mitigation has to be initiated. First, time to surgery should be minimized, because prolonged time to surgery is associated with progression of infection.[23] Second, the risk of sepsis and infection transmission may be further reduced by intravenous administration of antibiotics or antifungals. In patients with a possible or proven intra-abdominal infection, antibiotic treatment should be initiated as soon as possible.[3,24] The most suitable regimen for treatment of complicated intra-abdominal infection differs per case and depends on local protocols. However, it should always include broad-spectrum antibiotics.[25] In our patient, prophylactic broad-spectrum antibiotics should have been given. There are no guidelines which describe antifungal treatment of organ donors because fungal contamination is mostly not a donor-related problem.[13] According to the guidelines of the American Society of Transplantation, prophylactic antifungal therapy should be initiated in the recipient if yeasts are visualized on stain or isolated from the preservation solution.[13] Third, it is essential that the donated organ is not contaminated "per continuitatem" and that the contact between bowel contents and the kidneys is avoided. In situ preservation is a useful technique to flush and cool the abdominal organs without entering the abdominal cavity.[4] Although rapid laparotomy with direct cannulation of the aorta is recommended because of its speed and superior graft survival compared with ISP,[26,27] ISP may be a safer technique in case of intestinal perforation in all deceased donors, including donation after circulatory death and brain death donors. After ISP, kidneys can be removed carefully via bilateral lumbotomy. The renal fascia and perirenal fat further protect the donor kidneys against contamination.

It is advised that direct bacterial or fungal contamination of an organ should lead to rejection of the contaminated organ.[14] In accordance to the guidelines, we chose to exclude the liver and pancreas from donation. In the literature, all reported organs from donors with intestinal contamination were retrieved after a transabdominal approach, which causes a major risk of direct organ contamination. We decided to continue with kidney and lung donation because these organs are located in a different anatomical compartment. We felt that by our retroperitoneal approach, the short period of hospital admission, and absence of any increased markers for infection, the risk of direct contamination of organs would be low and the risk of donor to recipient disease transmission is acceptable. Indeed, we did not observe any bacterial or fungal growth in both machine perfusate cultures, and postoperatively, the recipients did not suffer from infection.

The demand of organs for transplantation greatly exceeds the supply. Discarding organs with an increased risk for the recipient would further compromise the limited donor pool and aggravate the organ donor shortage.[3] Moreover, many studies concluded that donors with increased risk should not be ruled out as possible donors.[3,14,16-18,28,29] In this singular case, we have shown that direct contamination of organs can be avoided with the use of ISP and a retroperitoneal approach. Deceased donors with intestinal perforation may be suitable for kidney and lung donation with a successful

TABLE 3.

Transplant information

	Left kidney	Right kidney
First warm ischemia time	24 min	24 min
Cold ischemia time	12 h, 12 min	15 h, 35 min
Anastomosis time	41 min	50 min
Mismatch		
A	0	1
B	2	1
DR	1	1
Kidney transplantation	First	Second
Kidney function	Delayed graft function	Immediate graft function
Kidney function after 6 mo	eGRF > 60 mL/min (MDRD)	eGRF >60 mL/min (MDRD)

outcome. However, this approach does not fully exclude the risk of bacterial or fungal contamination, and the risk of disease transmission has to be evaluated per case.

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